

Developing a Networked Public Display System

Engaging stakeholders in the design of networked public display systems is critical for long-term deployments. The authors describe the three-year development and installation of a display network at a university, revealing the fuzziness of stakeholder roles and need for compromise.

Nemanja Memarovic

University of Zurich, Switzerland

Ivan Elhart

University of Lugano, Switzerland

Elisa Rubegni

University of Applied Sciences and Arts of Southern Switzerland

Networked public displays have been envisioned as a new communication medium for the 21st century,¹ one that has a high potential for affecting place-based communities.² Previous work shows that engaging stakeholders and ensuring their acceptance of the system is a key factor for successful long-term deployment. Without their involvement, the system can be seen as intrusive and controversial, thus making it vulnerable to sabotage.³

According to Florian Alt and his colleagues,⁴ there are three types of stakeholders for networked public displays:

- display providers, who own the space and the displays;
- content producers, who create the content; and
- content viewers, who go to the displays to view the content.

Yet lessons and guidelines that help in engaging with these stakeholders and understanding their influence on the system design and deployment processes are rare. In organizations such as universities, which are comprised of different faculties with a variety of departments (including management, marketing, Web services, and IT) and members (students, professors, administrators, technicians, designers, economists, and secretaries), identifying these stakeholders and understanding how to involve them in the system design process is challenging.

Here, we report on our experiences of engaging with university officials and the student community for three years when installing a public display network and designing its applications and content. Overall, our work contributes to the knowledge of building and deploying pervasive display networks “in the wild.”

Public Displays Research

In recent years, there have been a number of reports on the various challenges of deploying public display systems. Oliver Storz and his colleagues were the first to discuss such challenges, based on their experience with building and deploying the eCampus system.⁵ They describe 13 lessons from deployments that took place in a conference setting, a brewery, and a university that cover aspects that need to be considered before, during, and after deployment. In the context of our work and stakeholder engagement, we found their lessons to be invaluable—in particular, the need to anticipate and plan for regulatory compliance issues, understand the resources and expenses needed for content creation, and prepare the team for public scrutiny.

Sarah Clinch and her colleagues, building on the work of Storz and his colleagues, developed the e-Channel system.⁶ In their work, they describe the process behind developing a channel system that allowed content producers to upload files to a display channel using a shared folder (similar to Dropbox) and allowed display owners to select which content (channel) they would show. Based on their experiences with real-world users, they describe lessons regarding content and its quality, as well as poor user appreciation of the efforts that go into building a system. As in our case, they also note that system deployment took an extended period of time (three years).

The work that falls closest to what we described here is that of Jörg Müller and his colleagues,⁷ who have described their approach using contextual inquiry to uncover the set of interaction properties and general stakeholders for a university display network. Most of their work focuses on the information update rate on public displays and how to present the information coming from different sources. Our work complements the work of Müller by describing the process of uncovering the stakeholders within the same type of setting—a university—and describing how to engage them to discover an appropriate set of applications to run on the display.

More recent work has focused on the specific challenges of deploying public display systems in community settings. Nick Taylor and Keith Cheverst discuss the iterative and participatory process of designing a public display system for a rural community.⁸ Their lessons show that researchers should be flexible in their participation and that a human access point—a person who interacts between the research team and the community—can greatly influence decisions regarding what should be done. Their work also shows that tensions can arise between researchers and participants. Other work by Taylor, Cheverst, and others has summarized lessons learned when handing over the system to the community, pointing out the need to carefully plan for the handover process.

Similarly, Steve North and his colleagues¹⁰ describe tensions between researchers involved in the design and development of networked urban displays and place owners and community members involved in the project. Within the space, Timo Ojala and his colleagues have described general problems of evaluating public display deployments.¹¹ It's also noteworthy that several works have looked into describing the effects of deployed public display systems on the community in which the displays were located—such as in work settings;¹² “third places,” such as cafes;¹³ and urban public spaces. Our work populates the space of engaging with stakeholders for a long-term deployment by discussing the various processes and their dynamics. We explain how we identified the stakeholders in the university setting and how the stakeholders can change during the various stages of deployment as their roles become more clearly defined. We also explore how stakeholder engagement can influence the set of applications and the deployment's start date.

Installation at the University of Lugano

We installed a public display network at the University of Lugano as part of the European research project “PD-Net: Towards Pervasive Display Networks”—a project set up to create a software architecture for this novel medium. The project also aimed to investigate the display network's impact on the surrounding passersby. Part of the goal was to have a permanent installation at the University of Lugano for long-term use by the university community.

The network was installed in February 2013 and has been up and running ever since. Overall, designing for a university community required a methodological approach to include the various stakeholders, so we adopted an approach inspired by cooperative design,¹⁵ using techniques such as focus groups, interviews, and observations.

Stakeholder Engagement

As noted earlier, there are three stakeholder types: display providers, content producers, and content viewers.⁴ Furthermore, according to Müller and his colleagues,⁷ these stakeholder roles can be connected to forwarders/filters, sources, and sinks, respectively. To a certain extent, forwarders/filters act similar to display providers, because they decide whether the content will appear, with the only difference being that they don't necessarily own the displays. Sources can be viewed as content producers, and sinks as content viewers.

Understanding and uncovering these stakeholders within a university setting comprising different faculties, suborganizations, and a variety of staff members was the first step in developing a display network.



Figure 1. Deployment setup for the first student welcome event. The stakeholders were satisfied with user engagement during the event, and the initial two-day deployment was prolonged for five more days.

Phase 1: Identifying Content Viewers and Producers

The first phase of the project lasted approximately 18 months, during which time we focused on identifying potential content viewers and producers.

We started by gaining an understanding of the university’s community and how different groups—that is, students, faculty members, and staff—are represented. In the beginning, we met with representatives from all three groups to inquire about their tasks and activities at the University of Lugano and their attitude toward information and communication technologies (ICTs). Students represented the largest group of potential users, and university officials were interested in improving institutional communication with them, so we decided that the students would be the content viewers.

To understand the type of content students wanted to see on a display network, we conducted interviews and a survey that looked into student use of currently widespread technology, including email, social networks, video conferencing, and chat tools.¹⁶ The study outcomes provided initial ideas for display content, ranging from official university content (such as news, events, and schedules) to student-produced content for socializing among themselves (such as photos posted on Facebook).

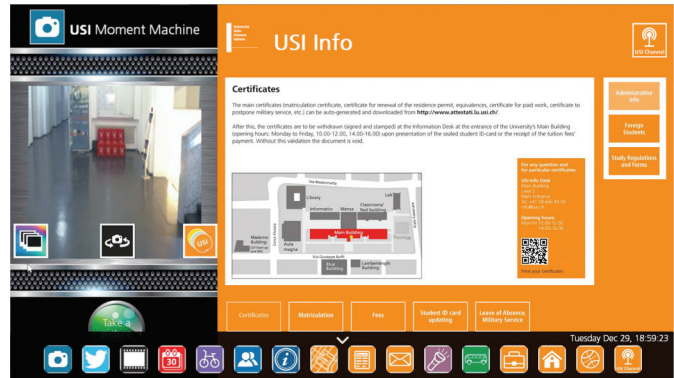
For the group of content producers, we needed people interested in producing content for the public display. As a first step, we interviewed the University’s Web services group, which produces a variety of official university content. The interview provided a starting point for further discussion with people who were in charge of organizing welcome events.

Phase 2: Developing Applications and Probing Deployments

Phase 2 lasted approximately one year. The focus of our activities was to



(a)



(b)

Figure 2. A generic slideshow application created for the Media and Communications (MACS) group. (a) The wall-mounted display in front of the canteen, and (b) the three different display areas: a smaller area on the left and bigger area on the right for the main applications, and a menu at the bottom of the screen for application selection.

engage the stakeholders, conduct preliminary tests with pilot deployments, and test the software developed.

One of the people in the Web services group we interviewed was also part of the Student Advisory Service (SAS) group, which organizes welcome events for potential new students. After the interview, the SAS group contacted us to create applications for one of their events. We were contacted shortly before the event, so we quickly switched our efforts from creating the software architecture to creating deployable and stable applications for the two-day event. We developed two applications—one that showed Instagram images and another that showed tweets tagged with a specific hashtag (see Figure 1). The two applications were used five months later for another event. During the probing deployments, the research team collaborated with the welcome event organizers in acting as display providers—that is, jointly deciding where to place the displays within the university.

Once we had improved our system (roughly eight months into phase 2), we contacted the SAS group and were redirected to another group in charge of university events—the Media and

Communications (MACS) group. The MACS stakeholders were interested in having a bundle of applications that could be divided in two types: applications that would show official university content, such as news, events, and schedules, and social applications that would promote interactions between students and others on campus.¹⁷ These interests aligned well with the interests of the content viewers (based on the students interviewed in phase 1). The overall goal of the MACS group was to have students engage with the content, which further established students as the main content viewers.

We decided jointly with the MACS stakeholders to create a generic slideshow application that would show content stored in a Dropbox folder, which supported easy content uploading and sharing as well as automatic updates for new content (see Figure 2a). For the social applications, we used the Twitter feeds application created for the test deployments and a version of the Instagram application modified to turn it into a photo booth application with support for posting and viewing situated snapshots. The photos were taken through a camera attached to the display. One of the requirements for both the display

and social applications was that their designs align with the university's corporate identity design. We thus jointly reached out to the graphical design department and engaged them in helping the researchers incorporate the appropriate colors, fonts, and logos.

To support interactions with multiple applications, we split the screen into three parts: a smaller area to the left, a bigger area to the right, and an application menu at the bottom (see Figure 2b). When users select a certain application from the bottom menu, it appears either in the left or right part of the screen (where the application appears depends on the scheduling algorithm¹⁷). Occasionally, the MACS stakeholders wanted to show their content exclusively in full-screen mode while displaying a message to let the users know when the display would resume its interactive state—such as “application selection available starting at 1:30.”

Phase 3: Running a Long-Term Deployment

Phase 3 lasted approximately six months. In this phase, we wanted to obtain a stable version of the software and run a long-term deployment.

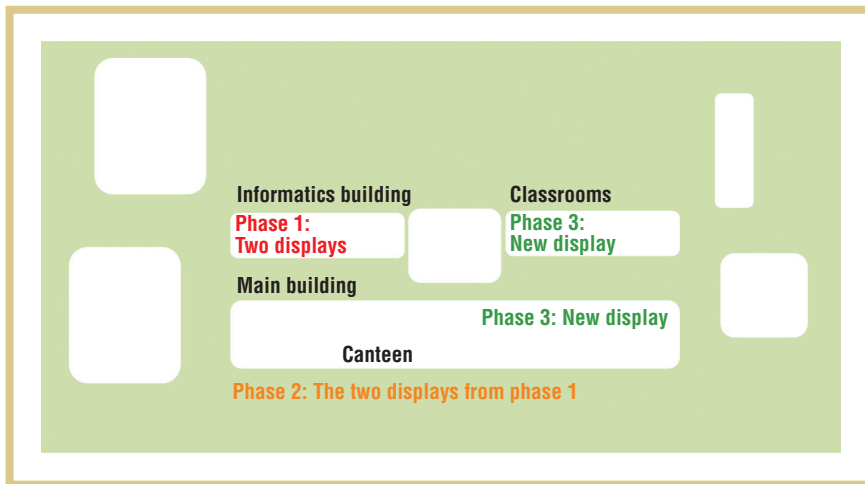


Figure 3. The University of Lugano campus. During phase 1, we had two touch displays in front of the Faculty of Informatics building. For phase 2, we changed locations to near the canteen in the main building. For phase 3, we added a display inside the main building and another display in front of a building full of classrooms.

We also wanted to have content producers create content for the network.

Throughout the negotiation process, we aimed to start the deployment at the beginning of the fall semester. However, this proved to be too soon for the MACS stakeholders, because they were not familiar with the technology. They also wanted to conduct more user trials and test deployments to better understand potential users' expectations for the official university content. Therefore, negotiations and communication for when the deployment would happen continued throughout the fall semester, with several event-based deployments and a final pilot deployment that lasted two weeks.

The location of the displays was determined jointly by the research team (based on our observations of students' habits) and the MACS stakeholders (based on their strategic goals and practical needs for ensuring efficient content delivery). Thus, we jointly acted as display providers. During phase 1, our touch displays were mainly in the Informatics building, which is

where most of the software development occurred, so the location helped us understand the different interaction and user interface possibilities (see Figure 3). In phase 2, we moved the displays for event-driven deployments to in front of the canteen in the main building and to an open public space near the canteen (also see Figure 1). However, as we approached phase 3 and were getting closer to having a stable deployment, we wanted to place a display on a wall inside the main building as well as in another building. This required getting approval from the head of the university, who, in this case, acted as the display provider. To convince him to install the display, the MACS stakeholders expressed their views about the usefulness of the displays. The four displays we installed (two near the canteen, one inside the main building, and one near the classrooms) have been up and running for approximately two years, and all four displays show the same applications.

During the first full-semester deployment, the MACS stakeholders insisted on pushing the institutional content that would be running in full-screen

mode, leaving little time for interactions with the social applications. Overall, their goal was to communicate with the students, but they weren't sure they had selected suitable content and were concerned they'd receive complaints from the other staff and faculty members. However, the content was well received, so the MACS stakeholders started investing more time in content creation. They also worried about inappropriate photos created through the photo-booth application, but this didn't turn out to be a significant problem—only 12 out of 1,412 photos (0.008 percent) were inappropriate. Furthermore, students loved interacting with the photo booth application, so the MACS stakeholders decided to give the social applications more display time.

In Figure 4, we show the number of application requests for the current deployment period for all four displays. The highest number of requests (311) was in week four, and the lowest (0) was during the semester breaks. On average, there were 47 total application requests per week for all four displays. When it comes to display use, the most used display was the one in front of the canteen (43 percent), followed by the one in the building with only classrooms (23 percent) and the two displays in the Informatics building (18 and 16 percent). The two most used applications were the photo-taking (25 percent) and photo-viewing (13 percent) applications, followed by the university news and events (9 percent) and Twitter (7 percent) applications.

Discussion

In our work, we set out to create a university display network and, in this process, we learned the importance of the following items.

Identifying an Executive-Level Display Provider

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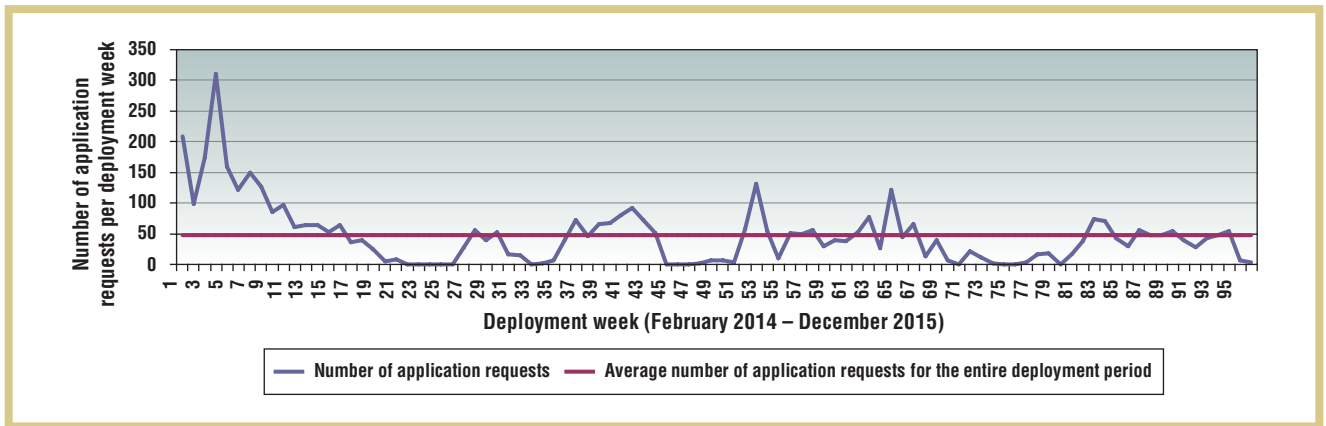


Figure 4. Number of application requests per deployment week since the display network became fully operational.

this process, we had to uncover the three types of stakeholders. Although it was relatively easy to determine the content viewers, identifying the display providers and content producers was a bit tricky and depended on the deployment phase. When running the probing deployments (phase 2), the role of display providers was shared between the research team and the event organizers. However, as we got closer to the long-term deployment (phase 3), we had to negotiate with the head of the university to get permission to install the displays in buildings other than where the software was being developed (in the Informatics building).

Based on our experiences, we can say that in probing deployments, the role of display providers is somewhat flexible and can be shared between the research team and the stakeholder. However, once the deployment becomes 24/7, the role of the display provider becomes clearer and the necessary permission to deploy the displays must be obtained from a higher-up in the organizational hierarchy. If possible, it's best to involve people in higher (such as executive-level) positions (the heads of schools or presidents of the university, for example) or to at least regularly inform such people about the status of the project to avoid last-minute work and pressure before the deployment.

Finding Committed Content Producers

When it comes to content producers in charge of the official university content, some produced one-off content for the events, while others produced content for a longer period. For certain events, the organizers were willing to jump into the role of content producers and develop the necessary content. However, for the longer deployments, content producers had to commit to a certain frequency (delivering content on a weekly basis, for example) over a longer period of time (such as a semester). Consequently, for the official institutional content, the role of content producer can vary depending on the type of commitment made—for short periods of time

Testing “In the Wild”

Throughout our deployment process, real-world university-organized events were crucial to our success. They not only provided the need and inspiration for the initial set of applications but also helped us test the developed software “in the wild” and collect user feedback. Although in our own case, we first conducted a series of investigations to uncover the stakeholders and later began developing the software architecture, the whole process (of uncovering stakeholders and developing software) could have started from the events themselves.

Overall, future developers could benefit from using university-organized events as a starting point for understanding the potential stakeholders and their practices

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(such as events), people find the time easily. However, for longer commitments (a semester-long deployment), you need to find content producers who can fit the content delivery into their work routine while still providing the level of quality needed.

and identifying the system and application requirements. In cases where event schedules are available, these could be used to plan the deployment process—determining when to contact event organizers, conduct observations, and have the first version of the software ready.

the AUTHORS



Nemanja Memarovic is a postdoctoral researcher at the University of Zurich. His research interests intersect ubiquitous computing, public spaces, and communities. Nemanja received a PhD in informatics from the University of Lugano. Contact him at memarovic@ifi.uzh.ch.



Ivan Elhart is a postdoctoral researcher at the University of Lugano. His research interests revolve around scheduling and developing applications for pervasive display networks. Ivan received a PhD in informatics from the University of Lugano. Contact him at ivan.elhart@usi.ch.



Elisa Rubegni is a senior researcher at the University of Applied Sciences and Arts of Southern Switzerland. Her research interests include interaction design for children, design in public spaces, and the interaction design process in general. Rubegni received a PhD in computer science from the University of Florence. Contact her at elisa.rubegni@supsi.ch.

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Reserving Time for Content Producers

Although the research team and the software were ready for the deployment on a negotiated date, content producers responsible for the official university content were not. They simply required more time to get familiar with content creation, as well as time to receive feedback from content viewers. As a result, we had to postpone the long-term deployment for a full semester and used this time to conduct scheduled user trials to collect user feedback for content producers.

Future developers could leverage this by knowing that, although they and their software might be ready to go, they still need to reserve time for content producers to see how well their efforts are appreciated by content viewers. This time should be accounted for in the overall deployment plan and should not be neglected—in our own case, user trials and test deployments lasted a full semester. If user trials for content producers are successful, content producers also become advocates of the system and can help in gaining

the necessary trust within the university community (for example, in our case, they helped convince the head of the university to place a display in front of the canteen).

Paying Attention to Uniformity

Lastly, one of the requirements for running the long-term deployment within the university setting was ensuring that all applications shared the university’s corporate graphical design. So, we had to work with someone in charge of corporate identity from the graphical design department. Future developers should consider this, providing a uniform look and feel for applications that is aligned with the university’s corporate identity.

We hope that our experiences inform researchers, developers, and university/organization stakeholders of the process of developing a public display network and how best to approach it. ■

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